



# Diesel 101

Workshop on Rhode Island Clean Diesel Program  
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# **What's Behind the Interest/Need for Diesel Emission Reduction Programs?**

- **Reducing emissions from diesel engines is one of the most important air quality challenges in RI**
- **Emissions are linked to asthma attacks, lost work and school days, and numerous other health impacts**
- **EPA has issued regulations to ensure that the diesel engines manufactured in the future will be significantly cleaner than those operating today**
- **Diesel engines are very durable, and older models will continue to be used for decades**
- **Significant funding is available to reduce diesel emissions from the legacy fleet of older vehicles**

# Pollutants of Concern

- **Fine particulate matter (PM<sub>2.5</sub>)**

- ▀ Black, sooty smoke that's given diesels a bad name
- ▀ Health effects can include aggravated asthma, chronic bronchitis, and premature death in people with cardiopulmonary disease
- ▀ Children and the elderly are especially at risk

- **Nitrogen oxides (NO<sub>x</sub>)**

- ▀ Reacts with volatile organic compounds when sunlight is present to form ground-level ozone, the primary constituent of smog
- ▀ Ozone and smog can harm human health, causing lung damage and a variety of respiratory problems)

- **Air toxics**

- ▀ Pollutants known or suspected to cause cancer or other serious health effects (such as reproductive problems or birth defects)

# Diesel Emission Sources



- State/Municipal

- ▀ school buses, refuse haulers, public works vehicles



- Transit

- ▀ transit buses and commuter locomotives



- Ports/Authorities

- ▀ ferries, tugboats, large ocean-going vessels, and port vehicles and equipment



- Construction

- ▀ cranes, pavers, excavators, and front loaders

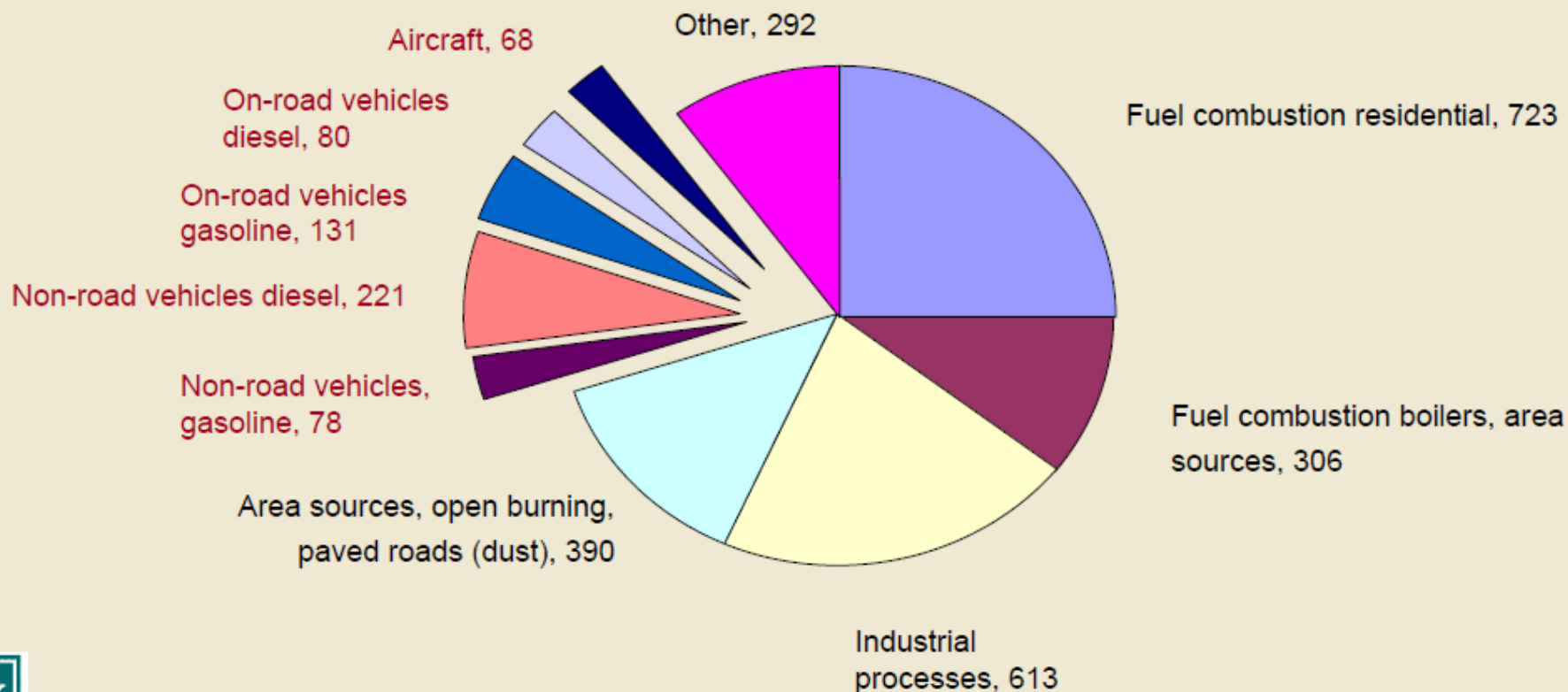


- Freight

- ▀ trucks, locomotives and locomotive switchers

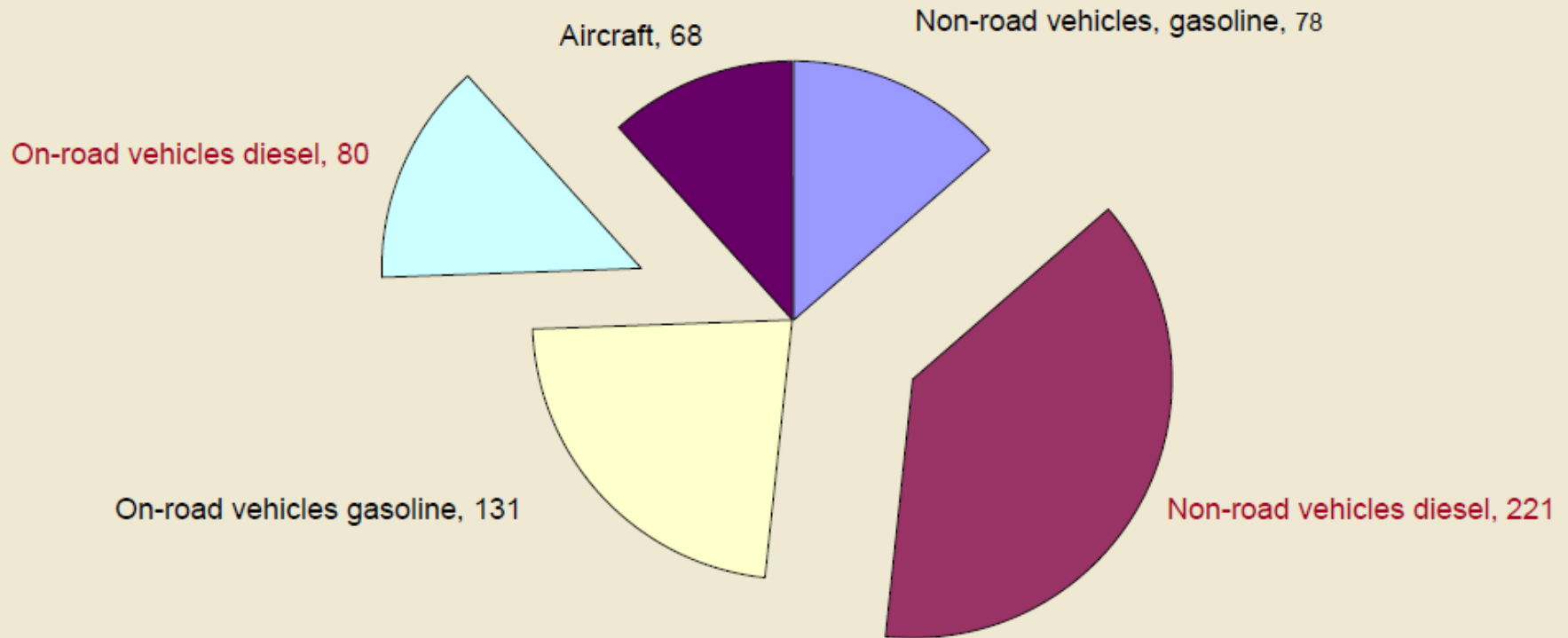
# Fine Particle Emission Sources

Rhode Island PM 2.5 Emissions from All Sources in 2002 (tons)



# Fine Particle Mobile Source Sources

Rhode Island PM 2.5 Emissions from Mobile Sources in 2002 (tons)



# Clean Diesel Strategies

## ➤ **Lower-emitting NEW diesel engines**

- More stringent Federal emissions standards for new on-road diesel vehicles and diesel construction vehicles and equipment; new rulemaking will reduce emissions from the diesel locomotive and marine engines of the future

## ➤ **Cleaner diesel - Ultra Low Sulfur Diesel (ULSD)**

## ➤ **Alternative fuels**

## ➤ **Retrofit technologies for LEGACY Vehicles**

- Significantly reduce unwanted emissions at reasonable costs without jeopardizing vehicle performance

## ➤ **Anti-Idling Efforts**

- In Rhode Island, the law is five minutes
- Education, outreach and technologies

# On-Road Diesel Fuel Sulfur Standards

- Up to 1993: 5,000 ppm
- 1993 to 2007: 500 ppm
- 2007 and beyond: 15 ppm



- Sulfur reduction is necessary to preserve the proper function of the advanced emissions control systems on new diesel engines
- Similar to eliminating lead from gasoline to protect catalytic converters



# Non-Road Diesel Fuel Sulfur Standards

**Table 2.1 Non-Road Diesel Fuel Standards**

Who	Covered Fuel	2006	2007	2008	2009	2010	2011	2012	2013	2014
Large Refiners & Importers	NON-ROAD	500+ ppm	500 ppm	500 ppm	500 ppm	15 ppm	15 ppm	15 ppm	15 ppm	15 ppm
Large Refiners & Importers	LOCOMOTIVE & MARINE	500+ ppm	500 ppm	500 ppm	500 ppm	500 ppm	500 ppm	15 ppm	15 ppm	15 ppm
Small Refiners and other exceptions	NON-ROAD, LOCOMOTIVE AND MARINE	500+ ppm	500+ ppm	500+ ppm	500+ ppm	500 ppm	500 ppm	500 ppm	500 ppm	15 ppm

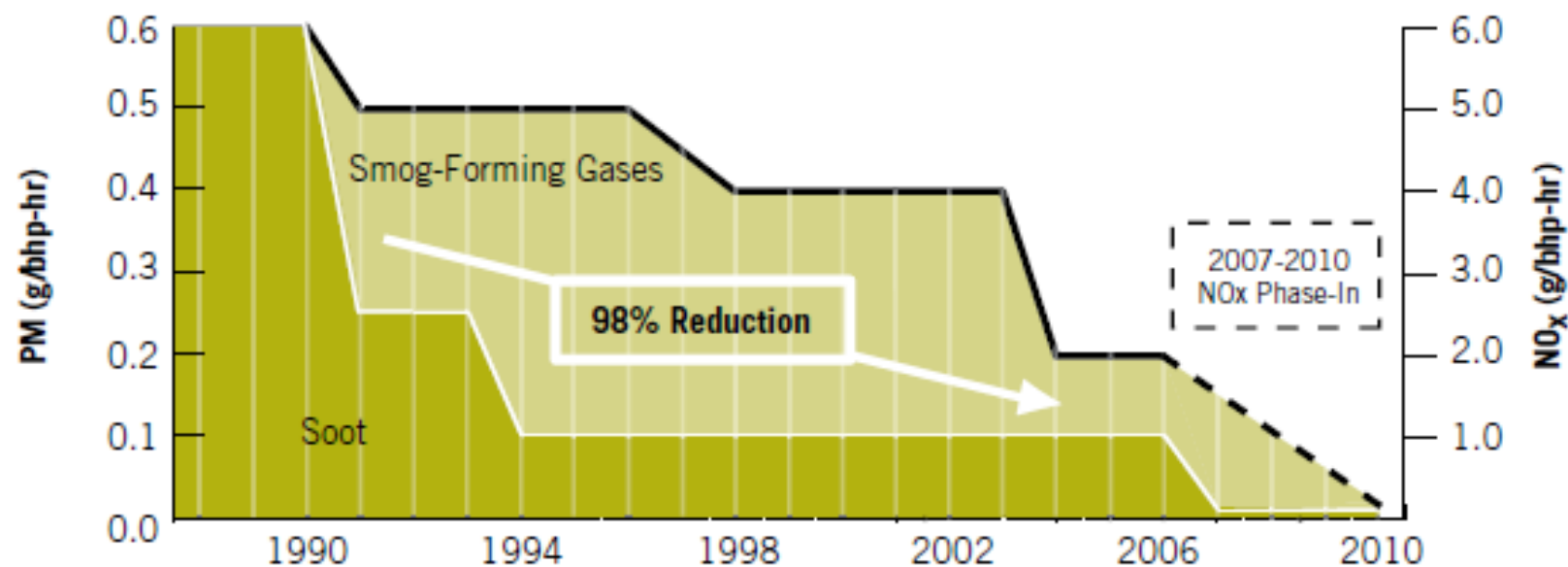
Except in California, compliance dates for Non-Road, Locomotive and Marine fuels are: June 1 for refiners and importers, August 1 downstream from refineries through fuel terminals, October 1 for retail outlets, and December 1 for in-use

In California, all diesel fuel will transition in 2006. Compliance dates for Non-Road fuels are: June 1 for refiners and importers, July 15 downstream from refineries through fuel terminals, and September 1 for retail outlets. Locomotive and Marine diesel fuels must transition to 15 ppm ULSD by January 1, 2007

*Source: Clean Diesel Fuel Alliance*

# New Diesel Engines are Much Cleaner

Figure 2.1 Diesel Emissions Reductions 1988-2010



Source: U.S. EPA On-Highway Heavy Duty Diesel Emissions

# Good News – Bad News

- **The good news is that recently established EPA regulations greatly reduce harmful emissions from NEW diesel engines. When fully implemented:**
  - will decrease exhaust emissions by 90+ percent
  - will achieve more than \$100 billion in health benefits
- **The bad news is that these engine emissions rules will apply only to newly manufactured engines**
  - With diesel engines lasting up to 30 years and with approximately 11 million engines in use today, the full benefits of these rules will not be realized for decades

# Strategies for Legacy Engines – 6R's

- **Retrofit** – emission control devices (filters, catalysts)
- **Rebuild** – repair/upgrade key components or engine reprogramming
- **Repower** – put new engine in existing equipment or chassis
- **Replace** – vehicle/equipment condition < value of new engine
- **Refuel** – cleaner diesel fuel (ULSD), emulsions or additives, bio-fuels, electrification
- **Reduce idling** – decrease engine idling to reduce emissions and save fuel

# Retrofit

- **Diesel retrofit involves the addition of an emission control device to remove emissions from the engine exhaust**
- **Retrofits can be very effective, eliminating up to 90 percent of pollutants in some cases**
- **Some examples of emission control devices:**
  - diesel oxidation catalysts
  - diesel particulate filters
  - NO<sub>x</sub> catalysts
  - devices to control crankcase emissions also exist
- **Fairly straightforward to install and operate**

# Rebuild

- **Diesel engines, especially large ones, represent a large capital investment**
- **Because of their high cost and durability, they often are rebuilt and reinstalled in existing or new vehicles**
- **Pollution levels from diesels, like other internal combustion engines, increase as the engines age**
- **Rebuilding diesel engines, on a normal or accelerated schedule, provides an opportunity to incorporate new technologies to significantly cut emissions**

# Repower

- Repowering involves replacing an existing engine with a new engine
- This strategy is most effective for use in diesel-powered equipment with a useful life longer than that of the engine
- Repowering provides an opportunity to install a new engine that meets much lower emission standards than the original engine, often in conjunction with fuel economy benefits and lower maintenance costs
- Repowering can also include converting diesel-powered equipment to electrical power or alternative fuels

# Replace

- **Replacement involves retiring higher polluting equipment from service before it would otherwise be retired**
- **Newer equipment that meets more stringent emission standards is purchased to replace the retired equipment**
  - sometimes in conjunction with retrofit devices or alternative fuels



# Refuel

- **Variety of alternative fuels can be used in diesel engines**
- **Some require little or no modification to the engine while others require engine conversion/replacement**
- **Some of the alternative fuels include:**
  - Emulsified diesel
  - Biodiesel
  - Natural gas
  - Propane
  - Ethanol
- **Hybrid engines**

# **Idling Technology Alternatives**

**Direct Fired Heaters**

**Auxiliary Power Units**

**Automatic Engine Idle System**

**Energy Recovery Systems**

**Truck Electrification**

**Advanced Truck Stop Electrification**

# Idling Myths and Facts

**Myth:** It's important to warm up the engine with a long idle period, especially in cold weather.

**Fact:** With today's school bus engines, bus and engine manufacturers routinely suggest a warm up time of less than five minutes. In fact, running an engine at low speed (idling) causes significantly more wear on internal parts compared to driving at regular speeds.

**Myth:** It's better for an engine to run at low speed (idling) than to run at regular speeds.

**Fact:** Running an engine at low speed causes twice the wear on internal parts compared to driving at regular speeds.

**Myth:** The engine must be kept running in order to operate the school bus safety equipment (flashing lights, stop sign). It's impossible to run this equipment off the internal circuitry of the bus because the battery will run down.

**Fact:** Safety equipment can be operated without the engine running through re-wired circuitry for up to an hour with no ill-effects on the electrical system of the bus.

# Idling Education and Outreach

**Implement a no-idling policy.**

**Post "no idling" signs and alert bus drivers, parents and administrators that engines should be turned off when a bus (or any vehicle) is waiting, or parked. Buses generally do not need to idle, except in cold weather.**

**Redesign bus parking zones. Move bus parking area away from school air intake vents and park buses at a diagonal to avoid front-to-back passing of emissions to help reduce students' exposure to emissions.**



# Summary

**Many Cost Effective approaches available to reduce diesel emissions**

**Most appropriate technologies and products for your fleet based on the specific engines you have, their age, vehicle type, application and cost-benefit considerations**

**Funding is available to reduce diesel emissions**

# Information Sources on the Web

**Northeast Diesel Collaborative**

<http://www.northeastdiesel.org>

**US EPA National Clean Diesel Campaign**

<http://www.epa.gov/cleandiesel>

**Diesel Technology Forum**

<http://www.dieselforum.org/meet-clean-diesel>

**Manufacturers of Emission Controls Association**

<http://www.meca.org>